TO CALCULATION OF STARTING PERFORMANCE OF THE CAGE INDUCTION MOTOR WITH ASYMMETRIC MAGNETIC CORE

Savrulin Sergey Alekseevich, Bakubaev Baurzhan Tursungalievich, Denisenko Victor Ivanovich, Moiseichenkov Alexander Nikolaevich.
Ural Federal university, Ekaterinburg, Russia, savrulin86@gmail.com

Abstract - Features of the design of a cage induction motor with an asymmetric magnetic core are considered. Recommendations for improving the operating performance and starting performance of cage induction motor with an asymmetric magnetic core are given.

Keywords - cage induction motor, asymmetric magnetic core, operating performance, starting performance.

In the field of production and operation of small and medium-sized induction motors, the most acute problem is the increase in the reliability of induction motors, the solution of which is a complex technical task. To solve this problem, a new induction motor with a detachable asymmetric magnetic flux conductor (ADAM) of the stator was developed at the Electrical Machines Department of UrFU together with CJSC "Uralelectromash" [1,2]. The prototype tests showed that the motor has acceptable performance and specific prospects for use in an electric drive for various purposes.

Fig. 1. The stator and the rotor of the prototype ADAM of a new design

A distinctive feature of ADAM with respect to serial cage induction motor type 4A80B4У3 is the stator design (Fig. 1). The stator core consists of 6 modules, the number of which is equal to the number of phase zones of the motor.

To simplify the technology of assembling the stator of the motor, and also for the purpose of intensifying the cooling, the connector in the yoke of the stator magnetostructure is executed "in an oblique joint" at the boundaries of the phase zones. This allows the stator coils to be wound directly on the tooth body.

To increase the reliability and service life in an induction motor with an asymmetric magnetic core, a two-row concentrated three-phase winding with a shortened pitch equal to 1/3 of the pole division is used. The use of concentrated winding increases the number of turns of the coils located in one groove. Both these factors lead to an increase in the inductive resistance of the stator winding diffusion, which can reach 10-15% of the mutual induction resistance. In the engine with a detachable stator, a new component of the flux of axial direction scattering appears [3]. To reduce the effect of this flow between the non-magnetic gasket is placed by two halves of the stator core.

The increased value of the inductive resistance of diffusion of the stator winding leads to a decrease in the overload capacity and starting torque. When ADAM operates as part of an adjustable drive from a frequency converter, this is not a significant restriction on the use of ADAM. In the case of motor operation from the network, it is necessary to provide the required values of overload capacity and starting torque. This task is solved at the design stage of ADAM.

To increase the overload capacity and starting torque, the electromagnetic calculation of the ADAM is performed at a lower value of the voltage and an increased current value of the stator winding, and the calculation of the operating and starting performance, as well as the further operation of the engine during operation, is carried out at the standard rated voltage, network. This approach makes it possible to compensate for the influence of the increased inductive resistance of the stator winding diffusion.

In Table. 1 and 2 and in Fig. 2 shows some results of calculations of ADAM rated power of 1.5 kW, rated speed 3000 rpm. Electromagnetic calculation is performed by an original technique developed at the Electrical Machines Department of UrFU. The calculation of the operating and starting performance is made in 2 versions: according to the standard procedure on the basis of the Γ-shape equivalent circuit diagram for induction motor, and also using the original method for calculating the operating and starting characteristics on the basis of the T-model equivalent circuit diagram developed for ADAM, taking into account the axial asymmetry of the magnetic circuit of the stator core. The results of calculating the torque-slip characteristics for the type-T equivalent circuit diagram are shown in Fig. 3.

Table 1.

Comparison of the mass of the core steel ADAM with the serial machine

Type of motor	Parameters					
	D_a, m	Z_1	l_δ, m	d, mm	m_{Fe}, kg	m_{Cu}, kg
4A80B4У3 (380V)	0.074	24	0.098	0.8	6.989	1.350
ADAM 220V	0.073	6	0.096	0.8	11.035	1.475
ADAM 200V	0.073	6	0.096	0.9	11.035	1.593
ADAM 190V	0.073	6	0.106	0.9	12.374	1.568
ADAM 180V	0.073	6	0.116	0.95	12.61	1.664

Table 2.

Results of calculations

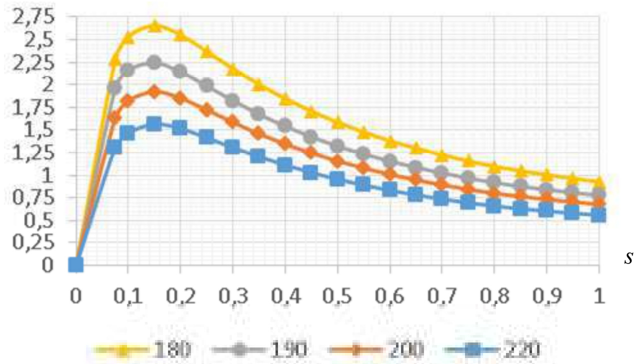
U_N, V	P_1, kW	I_N, A	I_0, A	η, p.u.	$cos\varphi$	η* $cos\varphi$, p.u.	T_l, p.u	T_b, p.u.
380	1.85	3.5	-	0.77	0.83	0.639	1.8	2
220	1.856	3.538	1.403	0.809	0.795	0.643	0.56	1.568
200	1.826	3.424	1.566	0.834	0.796	0.664	0.68	1.923
190	1.789	3.404	1.706	0.839	0.796	0.668	0.779	2.246
180	1.751	3.353	1.77	0.858	0.791	0.679	0.929	2.658

As shown by the above results, the electromagnetic calculation of the stator with reduced voltage of the stator winding makes it possible to provide the necessary levels of overload capability T_b and starting torque T_l of the ADAM without degrading the machine's energy parameters. Moreover, with this approach, there is a slight increase in efficiency. However, the improvement in performance indicators was achieved as a result of an increase in the consumption of electrical steel and winding copper within (10-15)%.

Calculations of the overload capacity and the starting torque of the ADAM, made by the type-T equivalent circuit diagram, gave an even greater effect on improving the performance. In this connection, an experimental verification of the developed methods of both electromagnetic calculation and calculation of the operating and starting performance is necessary.

Thus, an induction motor with an asymmetric magnetic circuit, which has the simplest stator winding design, while maintaining energy parameters at the level of series machines can become promising for use in both an adjustable and uncontrolled drive under severe operating conditions, where high reliability and long service life are required, as well as in extreme conditions of exposure to radiation fields and high temperatures.

T^*(p.u.)



I^*(p.u.)

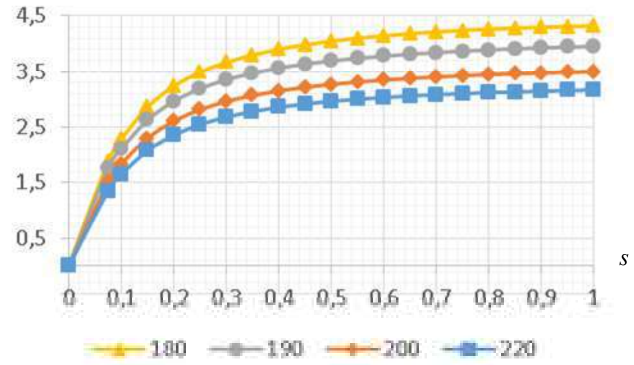


Fig. 2 - Starting characteristics of ADAM when working in a network with a nominal voltage at different calculated voltage values
(Г-shape equivalent circuit diagram).

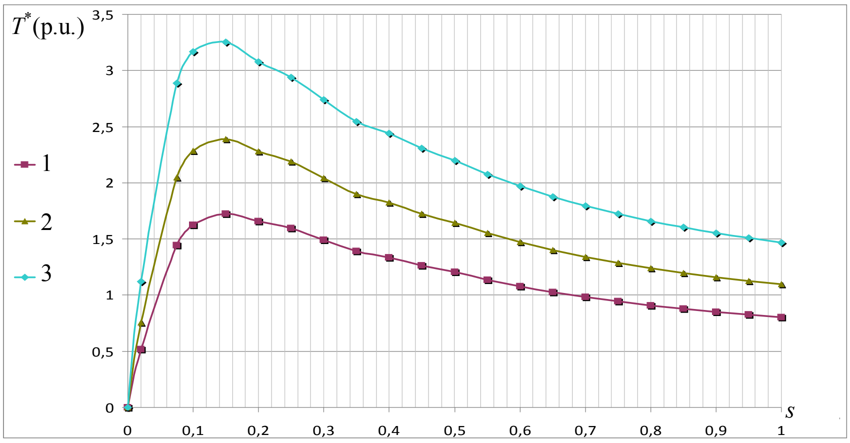


Fig. 3 - Torque-slip characteristics of ADAM when working in a network with a nominal voltage at different design values of voltage (T - shaped circuit of substitution): 1 - 220 V, 2 - 200 V, 3 - 180 V.

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